SR-68, 2600 South to I-15 in Davis County

Traffic Report

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1. Introduction

This section provides a brief summary of the overall project, the traffic analysis methodology, the analysis scenarios, and the report organization.

1.1 Background

The Utah Department of Transportation (UDOT) is proposing roadway improvements to an approximately 3.5-mile section of Redwood Road and 500 South, SR 68, located in Davis County, Utah. The project study area is located approximately 3 miles north of Salt Lake City and encompasses the corridor between the I-15 Southbound ramps in West Bountiful City to 2600 South in the City of Woods Cross. 500 South comprises the east/west portion of the study corridor from its terminus at Redwood Road to the I-15 ramps. Redwood Road comprises the north/south segment of this section of SR 68 from 2600 South to 500 South.

This section of SR 68 is composed of two travel lanes, one in each direction. The corridor has two signalized intersections and several unsignalized intersections and access points. Land uses within the corridor vary from rural residential to industrial. Shoulders, concrete curb and gutter, and sidewalks do not exist for most of the study corridor. South of the study corridor, SR 68 has a five-lane cross section, and to the east of the study corridor SR 68 has a five-lane cross section. Figure 1 displays the study area location.

1.2 Study Purpose and Analysis Scenarios

This report documents the analysis of traffic operations associated with existing conditions and the future alternatives. These scenarios will provide information on background traffic conditions and highlight existing and future traffic operational deficiencies.

The six study intersections along the corridor include:

1) I-15 Southbound Ramps and 500 South
2) 700 West and 500 South
3) 800 West and 500 South
4) 1100 West and 500 South
5) 1500 South and Redwood Road
6) 2600 South and Redwood Road

1.3 Analysis Methodology

The Highway Capacity Manual 2000 (HCM 2000) methodology was used in this study to remain consistent with "state-of-the-practice" professional standards. Synchro/SimTraffic software was used to apply this methodology. The traffic networks were built using Synchro 6.0 and micro-simulated using SimTraffic software. Micro-simulation was necessary to determine the impacts of the train crossings on the adjacent intersections. Results were calculated based on an average of five simulations.

1.3.1 Measures of Effectiveness

Four Measures of Effectiveness (MOEs) were used to quantify traffic conditions for the various scenarios. These MOEs were Level of Service (LOS), intersection delay (seconds/vehicle), travel time, and network wide delay (seconds/vehicles).

Figure 1 – Corridor Study Area

LOS is a measure of traffic operating conditions, which varies from LOS A (the best) to LOS F (the worst). LOS reflects the amount of congestions and delay motorists experience at intersections. The HCM 2000 methodology has different quantitative evaluations for signalized and unsignalized intersections. For signalized intersections, the LOS is provided for the overall intersection (weighted average of all approach delays). For unsignalized intersections LOS is reported based on the worst approach. Fehr & Peers has also calculated overall delay values for unsignalized intersections, which provides additional and useful information.

Tables 1 and 2 describe the LOS and delay criteria from the *HCM 2000* for signalized intersections and unsignalized intersections respectively.

Table 1 – Signalized Intersection LOS Criteria

LOS	Description	Average Delay (seconds/vehicle)
A	Operations with very low delay occurring with favorable progression and/or short cycle length.	≤ 10
B	Operations with low delay occurring with good progression and/or short cycle lengths.	> 10 to 20
C	Operations with average delays resulting from fair progression and/or longer cycle lengths. Individual cycle failures begin to appear.	> 20 to 35
D	Operations with longer delays due to a combination of unfavorable progression, long cycle lengths, or high volume-to-capacity ratios. Many vehicles stop and individual cycle failures are noticeable.	> 35 to 55
E	Operations with high delay values indicating poor progression, long cycle lengths, and high volume-to-capacity ratios. Individual cycle failures are frequent occurrences. This is considered to be the limit of acceptable delay.	> 55 to 80
F	Operation with delays unacceptable to most drivers occurring due to over saturation, poor progression, or very long cycle lengths.	> 80

Source: *Highway Capacity Manual* (Transportation Research Board, 2000)

Table 2 – Unsignalized Intersection LOS Criteria

LOS	Description	Average Delay (seconds/vehicle)
A	Little or no conflicting traffic.	≤ 10
B	The approach begins to notice absence of available gaps.	> 10 to 15
C	The approach begins experiencing delay for available gaps.	> 15 to 25
D	The approach experiences queuing due to a reduction in available gaps.	> 25 to 35
E	Extensive queuing due to insufficient gaps.	> 35 to 50
F	Insufficient gaps of suitable size to allow traffic demand to cross safely through a major traffic stream.	> 50

Source: *Highway Capacity Manual* (Transportation Research Board, 2000)

Travel time is the measure that is generally most easily understood by the traveling public. This report quantifies travel time in minutes and seconds by direction for the travel corridor.

The final MOE, Network wide delay, provides a comprehensive picture of congestion in the study area. This measure quantifies the average total trip delay (seconds/vehicle) experienced by vehicles in the network. The higher the network delay, the higher the overall level of congestion on the study corridor and cross streets.

1.4 Report Organization

The report is organized into the following four sections:

- ***Section 1 - Introduction*** discusses the purpose, analysis methodology, and organization of the report.
- ***Section 2 - Existing Conditions*** describes the existing corridor, data collection efforts, traffic characteristics, and results.
- ***Section 3 – 2030 Future No Build Conditions*** addresses future 2030 No Build traffic conditions including a description of the traffic forecasting process, roadway characteristics, and traffic operational results.
- ***Section 4 – 2030 Build Scenarios*** addresses future 2030 Build traffic conditions including a description of the roadway characteristics, and traffic operational results.

2. Existing Conditions

This section of the report describes the existing corridor characteristics and summarizes the data collection effort. The purpose of the existing (year 2005) analysis is to evaluate the intersections and roadways during the peak travel periods of the day under existing traffic and geometric conditions. Through this analysis, existing traffic operational deficiencies can be identified and potential improvements recommended. Technical data supporting these findings are included in Appendix A.

2.1 Existing Conditions Summary

This section summarizes the results of the existing conditions analysis. The data collected, evaluation methods, and results are provided and explained in the following sections. Analysis of the existing study corridor shows that some unsignalized side-street movements operationally fail (LOS F); however, overall the corridor operates acceptably (overall intersection LOS ranges from A to D for peak hour) under existing conditions. Existing corridor deficiencies are listed below:

- **Failing Traffic Movements** – (vehicles/hour on failing movement)
    - 700 West/500 South
        - Southbound right (14)
        - Southbound left (14)
    - 800 West/500 South
        - Northbound left (9)
        - Northbound through (46)
        - Southbound left (26)
    - 1100 West/500 South
        - Northbound left (7)
        - Northbound thru (66)
- **Segments lack sidewalk**
    - Both sides of SR 68, 1300 West – 2600 South
    - Intermittent – 1300 West to 800 West
- **Narrow shoulders and absence of turning lanes**
    - Vehicles turning left from SR 68 block the progression of through traffic for most accesses along the study corridor
    - The narrow cross section, high speeds, and high percentage of trucks during the day creates potential safety issues
- **Railroad operation**
    - During long train crossings, vehicles queue to the I-15 southbound ramp

2.2 Corridor Characteristics

The project study area is located approximately 3 miles north of Salt Lake City and encompasses SR 68 between 2600 South in the City of Woods Cross to the I-15 Southbound ramps in West Bountiful. The study corridor is a two-lane roadway with two active highway/rail crossings (Denver Rio Grand and Union Pacific). The Denver Rio Grand (DRGW) highway/rail crossing is located at approximately 1100 West/500 South and has approximately one train crossing per day. The Union Pacific (U.P) crossing is located at approximately 800 West and has approximately 36 crossings per day. The study corridor is also characterized by a high percentage of daily truck traffic (7-8%), and high speeds considering the uncontrolled access and lack of turn pockets. The posted speed limit on 500 South varies between 45 and 35 mph. The posted speed limit along Redwood Road varies between 55 and 45 mph.

Land uses along the corridor include residential, industrial, and agricultural. Study intersections along SR 68 are the I-15 southbound ramps, 700 West, 800 West, 1100 West, 1500 South, and 2600 South intersections.

2.3 Data Collection Effort

The data collection effort for the existing conditions included, daily and p.m. peak period traffic volumes, intersection geometry, signal timing, travel times, train crossings, and p.m. peak hour queuing conditions. This information was used to build, calibrate, and validate the existing conditions traffic model.

2.3.1 Daily and Peak Hour Volume Counts

Traffic counts were conducted for a 48-hour period from January 18th through the 20th, 2005 at two locations on SR-68. These locations were approximately 2600 South (Redwood Road) and 1500 West (500 South). Historical traffic volume data were also obtained for SR-68. Table 3 shows existing Average Daily Traffic (ADT) volumes and directional p.m. peak hour volumes.

Table 3 – Existing ADT and p.m. Peak Hour Volumes

SR 68	2004 ADT* (Two-way)	2005 p.m. Peak Hour Volume **	
		Northbound/Eastbound	Westbound/Southbound
500 S, I-15 to 800 West	17,205	852	520
500 S, 800 West to 1100 West	15,170	755	350
500 S, 1100 West to Redwood Road	11,325	781	180
Redwood Road, 500 S to 1500 S	6,535	723	180
Redwood Road, 1500 S to 2600 S	6,535	890	200
Redwood Road, south of 2600S	7,800	1,008	319

* From 2004 *Traffic on Utah Highways*, UDOT
** p.m. Peak Hour volumes were derived from peak period traffic counts.

The daily volume counts yielded directional traffic volumes in fifteen-minute intervals. These data verified that the p.m. peak period is the controlling period (i.e. the highest traffic volumes of the day) within the corridor. Peak period traffic counts were collected on Wednesday, August 3, 2005 and Tuesday, August 9, 2005 between 4:00 p.m. and 6:00 p.m. at the following study intersections:

- I-15 Southbound and 500 South
- 700 West and 500 South
- 800 West and 500 South
- 1100 West and 500 South
- 1500 South and Redwood Road
- 2600 South and Redwood Road

These counts were seasonally adjusted using information obtained from the Utah Department of Transportation (UDOT). Because the counts were collected on different days, the resulting p.m. peak hour volumes needed minor balancing adjustments. These volumes were balanced from the I-15 southbound ramp intersection.

2.3.2 Intersection Geometry

Intersection geometries were measured and during field visits to the corridor, and are included in Appendix A.

2.3.3 Signalized Intersection Timing and Phasing

Signal timing and phasing information were obtained from UDOT and are included in Appendix A.

2.3.4 Travel Times

Travel time studies were conducted during off-peak and p.m. peak periods to determine free-flow and congested travel times within the study area. The results are included in Appendix A.

2.3.5 Train Crossing Times

P.m. peak hour train crossing information was collected on August 4th and August 9th. At the UPRR crossing, Fehr & Peers observed a maximum of four gate arm activations during the p.m. peak hour (one false call and three train crossings). Discussions with UPRR on August 16, 2005 indicated that no set schedule exists for train operation at the 500 South location. The average train crossing time during the p.m. peak hour was 160 seconds. No train crossings occurred during the peak hours at the DRGW line.

2.4 Truck Traffic

The amount of truck traffic on a roadway reduces traffic capacity by requiring larger turning radii, increasing accelerating/deceleration times, and creating potential for slow moving vehicles. During the day, SR 68 experiences a substantial amount of truck traffic. Daily truck traffic in the study corridor according to UDOT's *Truck Traffic on Utah Highways 2004* varies from 7-8% (See Table 4).

Table 4 – Corridor Truck Traffic

Segment	Percent Trucks
I-15 Ramps – 1100 West	7%
1100 West – 2600 South	8%

Source: UDOT

Tube count information collected by Fehr & Peers on January 18-20, 2005 also classified the traffic into vehicle categories. Figures 2 and 3 on the following page show truck traffic percentages obtained from this data by hour of day for 500 South and Redwood Road respectively.

As shown in Figures 2 and 3, truck percentages tend to be the highest around 9 a.m. and lowest around 5 p.m. Figure 4 (following Figures 2 and 3) displays pictures of trucks operating on the existing roadway.

As shown in Figure 4, truck turning radii can only just be accommodated with the existing pavement cross-section. The following roadway deficiencies relate to truck traffic operations on the roadway:

- There are no additional lanes on 500 South for vehicles to pass slow moving trucks
- The narrow pavements section makes it difficult for large vehicles to turn
    - Sometimes trucks may overlap into adjacent lanes when turning

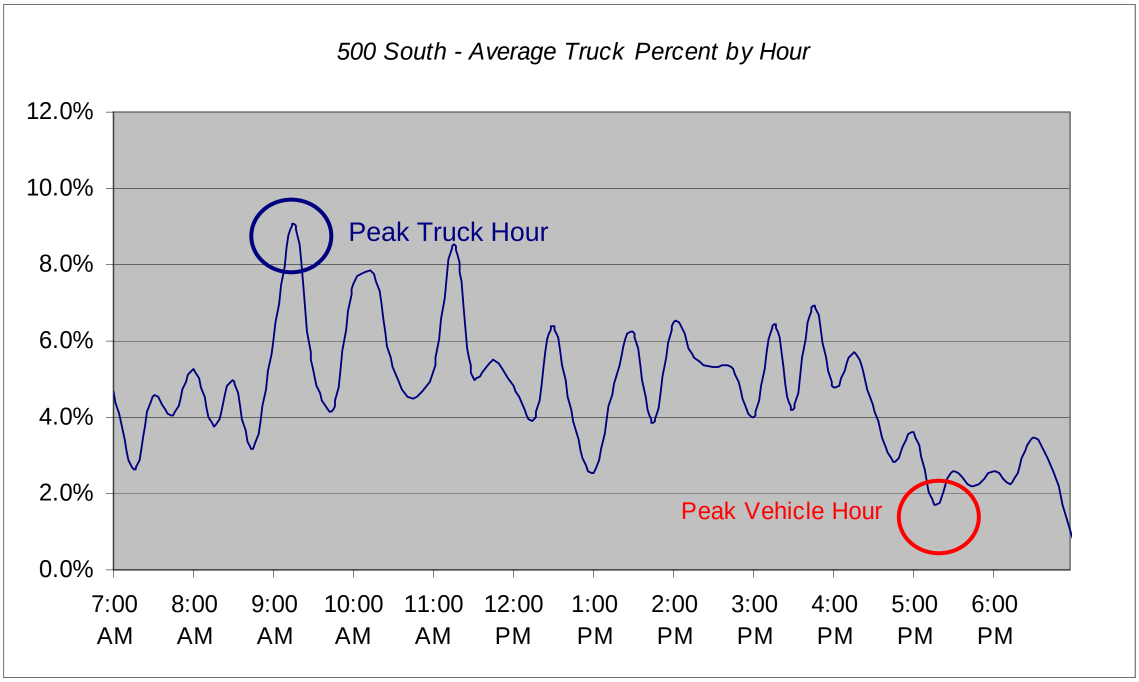

Figure 2 – Truck Traffic on 500 South 7 a.m. to 7 p.m.

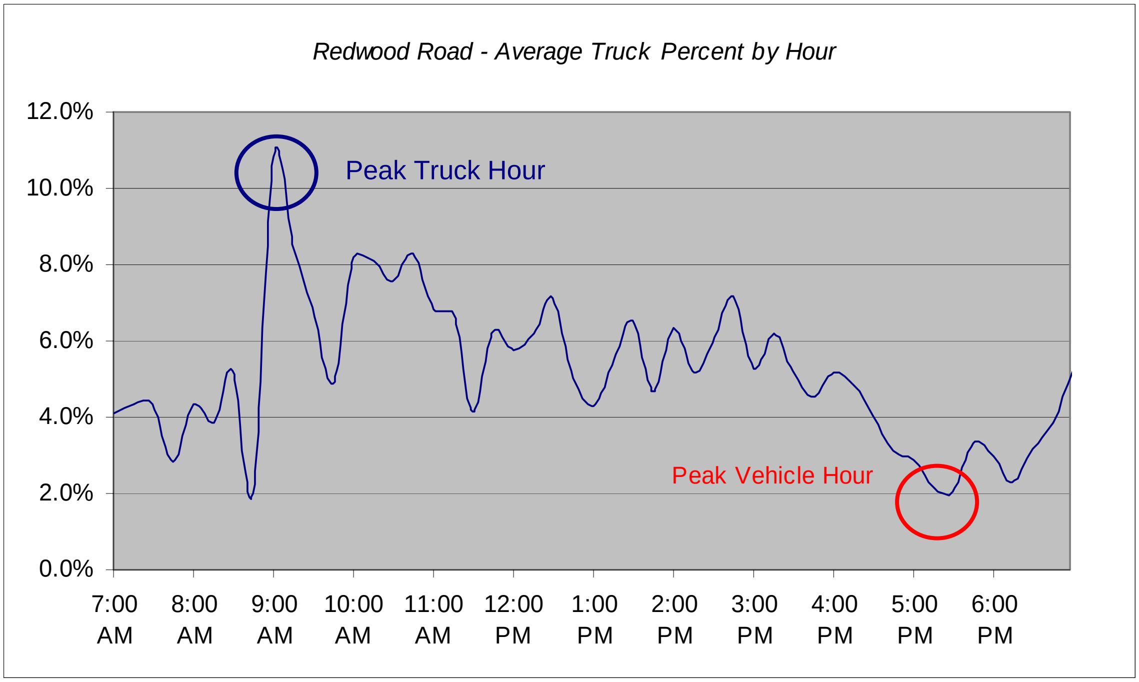

Figure 3 – Truck Traffic on Redwood Road 7 a.m. to 7 p.m.

Figure 4 – Truck Traffic Photos
a) Left – Semi Truck left turns from 2600 South to southbound on Redwood Road, b) Right – Trucks pass on Redwood Road

2.5 Access Management

Access management is the control of the types and spacings of driveways and intersections along a corridor. Proper access management improves traffic operations by restricting disruptive and/or dangerous traffic movements. A basic means of implementing access control is by providing curb and gutter. Without a definite curb and curb cut locations, property owners will tend to access the road in an unorganized manner. No curb, gutter, or sidewalk exists on either side of SR 68 between 1300 West and 2600 South. The north side of the SR 68 also lacks access control between 800 West and 1300 West. The average access spacings on 500 South and Redwood Road are summarized in Table 5.

Table 5 – Access Spacing *

SR 68 Segments	UDOT Class	Average Access Spacing (ft) / Shortest Spacing (ft)	UDOT Minimum Access Spacing Standards (ft)[1]	Local Minimum Access Spacing Standards (ft)[2]
500 South (I-15 – 1100 West)	Class VI Regional Urban	225 / 50	200	250
500 South (1100 West – Redwood Road)	Class V Regional Priority Urban	450 / 50	350	250
Redwood Road (500 South – 2600 South)	Class III System Priority Urban	650 / 200	2,640 Signal Spacing (No Unsignalized Access Permitted)	300

Notes:
* Including intersections and driveways
1) UDOT Access Management Standards
2) Woods Cross City General Plan (2003)

As shown in Table 5, the average access spacing on the 500 South portion of SR 68 meets the UDOT standards; however, the Redwood Road portion of SR 68 does not. In addition, the spacing of individual driveways on 500 South is often in violation of UDOT and local standards. As also shown in Table 5, some driveways along the study corridor are spaced as closely together as 50 feet. Some parcels have multiple driveways or the entire property frontage is one continuous uncontrolled access. At some locations, two neighboring properties have closely spaced driveways. Providing curb and gutter along the study corridor would resolve some of these problems.

Because Redwood Road is designated, from an access management perspective, a Class III roadway, no unsignalized access points should be provided on this road. However, several unsignalized access points are provided along the roadway.

The access management deficiencies for existing conditions are as follows:

- Unregulated access control along most of the SR-68 study corridor
- Unsignalized access points on Redwood Road
- Closely spaced driveways

2.6 Shoulders, Passing Lanes, and Turning Lanes

Shoulders, passing lanes, and turning lanes improve traffic flow by providing a buffer of safety for pedestrians and stalled vehicles, reducing the number of conflicts with through movements, and providing additional space for traffic to maneuver. The absence of adequate shoulder space and turning lanes increases the number of disruptions to traffic flow. Existing deficiencies along SR-68 with regard to shoulder space, passing lanes, and turning lanes include the following:

- Bicyclist and pedestrians are forced to utilize vehicle travel lanes
- No shoulder space for disabled vehicles
- Turning vehicles slow or stop through traffic flow
- Few opportunities exist for vehicles to pass slow moving vehicles

Figure 5 displays two of these potential problems.

Figure 5 – Existing Cross Section Photos
a) Left – Northbound cyclist on Redwood Road, b) Right – Vehicle turning left on 500 South

As shown in Figure 5a, the narrow shoulder causes a bicyclist to ride the shoulder line on Redwood Road. Figure 5b shows that through-vehicles would need to travel outside of the travel lane to pass a turning vehicle.

2.7 Traffic Analysis Methodology

The existing conditions network was built using Synchro 6.0 and micro-simulated using SimTraffic software. Micro-simulation was necessary to determine the impacts of the train crossings on the adjacent intersections. Results were calculated based on an average of five simulations.

Because no formal schedule exists for train crossings at this location, train crossings were replicated using the field data collected on August 4th and 9th. As previously mentioned the average U.P train crossing time was 160 seconds, and the greatest number of gate-arm activations during the p.m. peak hour was four. The p.m. peak hour gate-arm activations observed in the field occurred at least 15 minutes apart. Thus, the existing conditions model simulated four 2:40 minute train crossings during the p.m. peak hour with 15 minute headways between trains. The DRGW rail crossing was not included in the p.m. peak hour simulation because data collection efforts showed no train crossings at this location during the p.m. peak period.

2.7.1 Coordination with Commuter Rail EIS Methodology

The Commuter Rail EIS study area included 43 active highway/rail at-grade crossings. The 500 South/UPRR highway/rail at-grade crossing was one location analyzed as part of the project. This project made the same assumptions as the Commuter Rail EIS in regard to future train crossing activity at the 500 S/UPRR at-grade crossing. Commuter Rail service will add six shorter train crossings per peak hour to the four longer UP train crossings that occur during the peak traffic hour.

2.7.2 Existing Traffic Micro-simulation Model Validation

The existing Synchro/SimTraffic model was calibrated and validated using travel time and queue length information. The travel time information was collected during the p.m. peak hour on August 9th. No train crossings occurred during the travel time runs. Therefore the train feature was turned off to validate SimTraffic travel times. The SimTraffic travel times were calibrated within 5% of the field collected data. Table 6 displays the simulated travel times compared to the field collected travel times.

Table 6 – 2005 p.m. Peak Hour Travel Times Validation (excluding Trains)

Direction	Field Measured	Simulated	Difference
Northbound/Eastbound	5:27 minutes	5:30 minutes	*3 second (1%)*
Westbound/Southbound	4:17 minutes	4:06 minutes	*11 seconds (4%)*
Source: Fehr & Peers 2005			

The queue length information was collected during times with and without trains. Specifically, queues were measured during a train crossing lasting 3 minutes and 45 seconds. Thus the SimTraffic queue lengths on 500 South were validated against a simulated train crossing time of 3:45 minutes. Queues on 500 South during the train crossing were validated within 100 feet of the field collected data. Table 7 displays the simulated queue lengths vs. the field collected queue lengths on 500 South.

Table 7 – 2005 p.m. Peak Hour Queue Length Validation

Direction	Field Measured	Simulated	Difference
Northbound/Eastbound	1310 feet	1402 feet	*92 feet (7%)*
Westbound/Southbound	980 feet	947 feet	*33 feet (3%)*
Source: Fehr & Peers 2005			

2.8 Existing Conditions Results

Existing conditions Measures of Effectiveness (MOEs) are reported in the following order: LOS and delay, travel time, and network wide delay. Table 8 displays the existing 2005 LOS and delay (seconds/vehicle) for signalized and unsignalized study intersections. Table 8 also displays worst movement conditions for unsignalized intersections.

Table 8 – 2005 p.m. Peak Hour LOS and Delay			
Intersection	**Control**	***Worst Movement*** **LOS / Delay**	**Intersection LOS / Delay**
I-15 SB Ramps / 500 South	Signalized	N/A	D / 37.0
700 West / 500 South	NB/SB stop controlled	*SB Left* F / >50.0	C / 18.5
800 West / 500 South	NB/SB stop controlled	*SB Left* F / >50.0	D / 29.1
1100 West / 500 South	NB/SB stop controlled	*NB Left* F / >50.0	B / 12.5
1500 South / Redwood Road	WB stop controlled	*WB Left* A / 9.9	A / 4.1
2600 South / Redwood Road	Signalized	N/A	B / 12.4

Notes:
1) NB = northbound, SB = southbound, EB = eastbound, WB = westbound
2) Delay = seconds per vehicle
3) Signalized intersections report average delay for all movements, rather than delay for worst movement
Source: Fehr & Peers 2005

Table 9 displays average existing travel times assuming four U.P. train crossings during the p.m. peak hour between I-15 and 2600 South.

Table 9 – 2005 p.m. Peak Hour Travel Times	
Direction	**Average including Trains**
Northbound/Eastbound	6:40 minutes
Westbound/Southbound	4:54 minutes

Source: Fehr & Peers 2005

Table 10 displays the network wide delay for the existing conditions network simulation.

Table 10 – 2005 p.m. Peak Hour Network Wide Delay	
Scenario	**Delay (seconds/vehicle)**
Existing Conditions	68

Source: Fehr & Peers 2005

2.9 Existing Conditions Summary

The corridor has sufficient capacity for existing traffic; however, some side streets experience substantial delay, especially during times of train crossings. Train crossings cause traffic to back up on SR-68, hindering turning movements from the side streets. During long train crossings westbound traffic currently queues to the I-15 southbound ramps and eastbound traffic queues past 950 West.

Of the three side streets that fail operationally under existing conditions, two meet the peak hour volume warrant for signalized intersections as outlined in the Manual for Uniform Traffic Control Devices (MUTCD 2003). The intersections meeting signal warrants are 800 West/500 South and 1100 West/500 South. Signalizing these intersections would improve side street operation; however, system continuity, coordination with railway operations, and additional signal warrants should be considered prior to signal implementation. In addition, the south leg of the 500 South/800 West intersection will be eliminated in the future to accommodate commuter rail. This change may alter travel patterns and the recommendation for signalization in the future.

The existing traffic operational deficiencies and potential improvements are listed below.

Existing Corridor Deficiencies:

- **Operationally Failing Traffic Movements** – (vehicles/hour on failing movement)
  - 700 West/500 South
    - Southbound right (14)
    - Southbound left (14)
  - 800 West/500 South
    - Northbound left (9)
    - Northbound through (46)
    - Southbound left (26)
  - 1100 West/500 South
    - Northbound left (7)
    - Northbound thru (66)
- **Segments lack sidewalk**
  - Both sides of SR-68, 1300 West – 2600 South
  - Intermittent – 1300 West to 800 West
- **Narrow shoulders and absence of turning lanes**
  - Vehicles turning left from SR-68 block the progression of through traffic for most accesses along the study corridor
  - The narrow cross section, high speeds, and high percentage of trucks during the day creates potential for safety issues
- **Railroad operation**
  - During long train crossings, vehicles queue to the I-15 southbound ramp

Potential Improvements:

- **Signalize**
  - 700 West/500 South (Depending on future traffic volumes)
  - 800 West/500 South (Depending on future traffic volumes)
  - 1100 West/500 South(Depending on future traffic volumes)
- **Access Management**
  - Provide curb, gutter, and sidewalk
    - North/east sides of SR-68 800 West – 2600 South
    - South/west sides of SR-68 800 West – 1000 West and 1300 West – 2600 South
  - Provide better access management along the corridor
    - Consolidate driveways
    - Consider restricting movements at select unsignalized intersections (i.e. 700 West)
- **Widen shoulders, add two-way left turn lane, and/or increase number of travel lanes**
  - Increase intersection turning radii for truck traffic
  - Separate left-turning vehicles from travel lanes by providing a two-way-left-turn-lane in areas with multiple access points.
  - Provide additional travel lanes
    - Widen SR-68 study corridor to two travel lanes per direction
  - Provide a shoulder for pedestrians/bikes, stalled vehicles, and/or turning vehicles
- **Grade Separate U.P. railroad crossing**
  - Recommendation will depend on future traffic operations, along with other environmental and financial considerations

3. 2030 No Build Conditions

This section of the report describes the 2030 No Build traffic operational characteristics. The purpose of the 2030 No Build conditions analysis is to evaluate the intersections and roadways under future traffic conditions without improvements. This analysis serves as the future baseline for comparison with future improvement scenarios.

3.1 Corridor Characteristics

The 2030 No Build scenario assumes that no improvements will be made to the study corridor by 2030 (for a corridor description see Section 2.2). However, other roadway/transit improvements were assumed to take place by 2030. The relevant transportation changes in the vicinity of the study corridor are listed below:

- Legacy Parkway (new 4-lane facility west of SR-68)
- I-15 improvements from 600 North (Salt Lake County) to US-89/I-15 Junction (Davis County)
- Single Point Urban Interchange (SPUI) at 500 South & I-15 Ramps
  - Preliminary design plans for this interchange reconstruction show 500 South widened to four lanes through the interchange to 700 West
- Commuter Rail (new north/south corridor from Salt Lake City to north of Ogden)
  - The rail road track crosses 500 South at approximately 800 West
  - This project will eliminate the south leg of the 800 West/500 South intersection
  - The south leg of 800 West will be realigned to connect with 700 West

3.2 Travel Demand Model

The Wasatch Front Regional Council (WFRC) Travel Demand Model version 4.2, released January 2005, was used to estimate future year 2030 traffic volumes. Appendix B contains technical data detailing the forecasting process.

3.2.1 Model Scenarios

Appropriate files set-up and coding (highway, transit, socio-economics) was performed to create two regional travel mode runs:

1) Existing Conditions (2005 Base): The base year model run of WFRC model version 4.2 was used for the purposes of checking the validity of the travel model at the corridor level, and for comparing to model forecasts of 2030 traffic, which is then used to estimate peak hour traffic growth. No modifications were made to the existing (2005) land use data or highway network inputs used in WFRC model version 4.2.

2) Future Conditions (2030): This model scenario utilized the default 2030 land use data and 2030 highway and transit networks, i.e., the highway and transit networks that represent the December 2003 Long Range Plan (LRP) transportation system (including the proposed Legacy Parkway).

A reasonableness check of both input and output files was conducted prior to and following each model run. Reasonableness checks included:

- Comparing forecast volumes for each of the scenarios against each other. (Traffic volumes on Redwood Road should increase as land use and roadway capacity increases.)
- Traffic route checks to observe the origins and destinations of vehicles using SR-68.

3.2.2 Development of Peak Hour Traffic Volumes

As discussed, the WFRC regional travel demand model was used to develop future year 2030 traffic volumes. Utilizing the FURNESS method outlined in the National Cooperate Highway Research Program (NCHRP) Report 255, modeled growth rates were used as the basis for developing future year 2030 p.m. peak hour intersection turning movement volumes. The future traffic volumes were used for the purposes of analyzing corridor and intersection traffic operations.

In developing peak hour traffic volumes, the following forecasting issues were considered:

- The growth rates between p.m. peak period (3-hour) 2005 and the 2030 models were applied to existing p.m. peak hour counts to generate future forecasts.
- These growth rates were checked against historic ADT's for this section of SR-68 and were determined to be reasonable (see Appendix A for historic count information).

Using this approach further reasonableness checks were performed and turning movement forecasts were adjusted in accordance with accepted traffic forecasting practice to produce the year 2030 traffic volumes used in this study. The resulting intersection turning movement forecasts within the corridor are reported in Appendix C.

Table 11 depicts the traffic within the corridor. These volumes represent an average of the link volumes within the roadway segment.

Table 11 – Directional Volume Comparison

SR-68	Daily 2-way Traffic Volumes			p.m. Peak Hour Analysis Scenario				
	Existing	Future	% Growth	Existing 2005		Future 2030		% Growth
	2005	2030		NB/EB	WB/SB	NB/EB	WB/SB	(2-way)
500 S, I-15 to 800 West	17,205	20,750	21%	852	520	1,200	670	36%
500 S, 800 West to 1100 West	15,170	19,600	30%	755	350	1,095	675	60%
500 S, 1100 West to Redwood Road.	11,325	19,700	74%	781	180	1,175	600	85%
Redwood Road, 500 S to 1500 S	6,535	12,500	90%	723	180	1,140	315	60%
Redwood Road, 1500 S to 2600 S	6,535	13,150	100%	890	200	1,280	320	47%
Redwood Road, South of 2600 S	7,800	14,900	91%	1,008	319	1,410	465	41%

3.3 Traffic Analysis Methodology

The 2030 No Build traffic network was built using Synchro 6.0 and micro-simulated using SimTraffic software. Micro-simulation was necessary to determine the impacts of the train crossings on the adjacent intersections. Results were calculated base on an average of five simulations.

As previously mentioned in Section 3.1, several transportation changes are planned in the vicinity of the study corridor. These transportation changes required the following adjustment to the Synchro/SimTraffic traffic model:

- The south leg of the 800 West/500 South intersection was eliminated
- Commuter Rail trains were added to the U.P. highway/rail crossing
    - Per planned service characteristics for commuter rail, six commuter rail trains were simulated to cross 500 South during the peak hour. If one train crosses alone, a gate closure of 90 seconds was assumed. If two commuter rail trains crossed 500 South together, a closure of 160 seconds was assumed.
    - The four peak hour U.P. train crossings were assumed to continue to occur. Each of these crossings were assumed to require gate closure for 160 seconds.
    - Eight total gate closures on 500 South were assumed to accommodate the ten peak hour train crossings on the U.P. tracks
    - No peak hour train crossings were assumed to occur at the DRGW crossing, consistent with existing patterns of off-peak train crossings.
- 500 South was extended westward to intersect Legacy Parkway at the proposed interchange location
- A signalized intersection was created at the modified intersection of 500 South and Redwood Road. It was assumed that this intersection would warrant signalization in the No-Build condition, prior to 2030, and that the signal improvement would be made locally.
- The I-15 interchange was converted to a SPUI configuration per the I-15 North Corridor DEIS
    - This includes widening 500 South to four travel lanes through the interchange until 700 West

3.4 No Build Conditions Results

2030 No Build MOEs are reported in the following order: LOS and delay, travel time, and network wide delay. Table 12 displays the 2030 No Build LOS and delay (seconds/vehicle) for signalized and unsignalized study intersections. Table 12 also displays worst movement conditions for unsignalized intersections.

Table 12 – 2030 No Build p.m. Peak Hour LOS and Delay

Intersection	Control	***Worst Movement*** **LOS / Delay**	**Intersection LOS / Delay**
I-15 SB Ramps / 500 South	Signalized	N/A	C / 31.9
700 West / 500 South	NB/SB stop controlled	*NB Left* F / >50.0	F / >50.0
800 West / 500 South	NB/SB stop controlled	*SB Left* F / >50.0	F / >50.0
500 South / Redwood Road	Signalized	*N/A*	C / 26.2
1100 West / 500 South	NB/SB stop controlled	*NB Thru* F / >50.0	F / >50.0
1500 South / Redwood Road	WB stop controlled	*WB Left* E / 43.1	A / 8.3
2600 South / Redwood Road	Signalized	N/A	F / >80.0

Notes:
1) NB = northbound, SB = southbound, EB = eastbound, WB = westbound,
2)Delay = seconds per vehicle
3) Signalized intersections report average delay for all movements, rather than delay for worst movement
Source: Fehr & Peers 2005

Table 13 displays average 2030 No Build travel times assuming eight gate closures to accommodate train crossings during the p.m. peak hour.

Table 13 – 2030 No Build p.m. Peak Hour Travel Times	
Direction	**Average including Trains**
Northbound/Eastbound	9:13 minutes
Westbound/Southbound	8:14 minutes
Source: Fehr & Peers 2005	

As shown in Table 13, the eastbound travel time increases approximately two-and-a-half minutes over the existing conditions and the westbound travel time increases approximately three minutes over the existing conditions. Table 14 displays the network wide delay for the 2030 No Build network.

Table 14 – 2030 No Build p.m. Peak Hour Network Wide Delay	
Scenario	**Delay (seconds/vehicle)**
2030 No Build	320
Source: Fehr & Peers 2005	

The 2030 No Build network delay is almost five times as great as the 2005 network wide delay (see Table 10).

3.5 2030 No Build Summary

The two-lane corridor does not have sufficient capacity for 2030 No Build traffic, and the side streets will experience substantial delay, especially during train crossings. By 2030, all of the unsignalized study intersections are forecasted to meet the peak hour volume warrant for signalized intersections as outlined in the Manual for Uniform Traffic Control Devices (MUTCD 2003). Signalizing these intersections would improve side street operation; however, system continuity, coordination with railway operations, and additional signal warrants should be considered prior to signal implementation. Mitigation measures and signal assumptions are further discussed in the following sections. The 2030 No Build roadway deficiencies and some potential solutions are listed below.

2030 No Build Corridor Deficiencies:

- **Failing Study Intersections** – (vehicles/hour for failing intersection)
  - 700 West/500 South (2,300)
  - 800 West/500 South (2,000)
  - 1100 West/500 South (2,300)
  - 2600 South/500 South (2,000)

- **Segments lack sidewalk**
  - Both sides of SR-68, 1300 West – 2600 South
  - Intermittent – 1300 West to 800 West
- **Narrow shoulders and absence of turning lanes**
  - Vehicles turning left from SR-68 block the progression of through traffic for most accesses along the study corridor
  - The narrow cross section, high speeds, and high percentage of trucks during the day creates potential safety issues
- **Railroad operation**
  - In the eastbound direction vehicles queue to the I-15 ramps
  - In the westbound direction a rolling queue extends through the 1100 West intersection

Potential Improvements:

- **Signalize**
    - 700 West/500 South
    - 800 West/500 South
    - 1100 West/500 South
    - 1500 South/Redwood Road
- **Access Management**
    - Provide sidewalk
        - North side of the street 800 West – 2600 South
        - South side of the street 800 West – 1000 West and 1300 West – 2600 South
    - Provide better access management along the corridor
        - Consolidate driveways
        - Consider restricting movements at select unsignalized intersections (i.e. 700 West)
- **Widen shoulders, add two-way left turn lane, and/or increase number of travel lanes**
    - Increase intersection turning radii for truck traffic
    - Separate left-turning vehicles from travel lanes by providing a two-way-left-turn-lane in areas with multiple access points.
    - Provide additional travel lanes
        - Widen SR-68 study corridor to two travel lanes per direction
    - At minimum create a graded shoulder area for pedestrians/bikes and/or stalled vehicles
- **Grade Separate U.P. railroad crossing**
    - Recommendation will depend on future traffic operations after all other improvements are made, environmental, and financial considerations.

4. 2030 Build Scenarios

This section of the report describes the 2030 Build scenarios and their respective corridor characteristics. The purpose of the 2030 Build conditions analysis is to evaluate future traffic operations if various improvements are made. This analysis quantifies operational improvements compared to the 2030 No Build Alternative and highlights scenarios that meet project purpose and need.

4.1 Build Scenario Characteristics

All Build scenarios assumed that the improvements described in section 3.1 would be completed by 2030. The following sections describe specific elements of the highway Build scenarios considered in this analysis. It should be noted that these scenarios could be further varied according to the side of roadway chosen for right-of-way takes; however, possible variations in right-of-way takes will not alter traffic operation results. The No Build Alternative described in section 3 is considered to be 2030 Scenario 1. Details of the technical analysis for the 2030 Build Alternatives is included in Appendix D.

2030 Scenario 2: *3-Lane Transportation System Management (TSM) without UPRR Grade Separation*
This scenario assumed that 500 South would remain with one travel lane in each direction; however, other transportation system management (TSM) improvements such as adding turning lanes, extending turn pockets, intersection signalization, signal timing optimization, traffic channelization, and access management measures were included in this scenario. This scenario maximizes operations at intersections along the corridor without adding additional through lane capacity or grade separating the railroad crossings.

2030 Scenario 3: *3-Lane Transportation System Management with UPRR Grade Separation*
This scenario includes all of the improvements listed in the above scenario and in addition includes grade separation of the UPRR crossing. This scenario represents the best possible scenario for SR 68 without adding through lane capacity.

2030 Scenario 4: *5-Lane without UPRR Grade Separation*
This scenario includes the TSM improvements listed in Scenario 2 and widens the entire study corridor cross-section to five-lanes (two through lanes per direction, and a center turn lane). This scenario does not provide grade separation of the UPRR crossing at 800 West/500 South. This scenario represents the most benefit that can be derived from just widening the road.

2030 Scenario 5: *5-Lane with UPRR Grade Separation*
This scenario includes the improvements from Scenario 4 listed above and in addition grade separates the railroad crossing at 800 West/500 South.

2030 Scenario 6: *5-Lane with UPRR Grade Separated - 800 W closed at 500 S – 700 West (non-grade separated) By-pass Route*
This scenario includes the Scenario 5 improvements and provides a 700 West non-grade separated railroad by-pass route. In this scenario, the intersection at 800 West/500 South is completely eliminated, and the north leg of the intersection is converted to a cul-de-sac. Access between 500 South and 800 West would be provided by a by-pass route between the intersection at 700 West/500 South and approximately 800 West/200 South. The UPRR highway/rail crossing on 500 South would be grade separated, but the by-pass route would be at-grade.

2030 Scenario 7: *5-Lane with UPRR Grade Separated 700 West By-pass Route*
This scenario includes the Scenario 4 improvements listed above and provides a grade separated by-pass via 700 West. In this scenario, the UPRR highway/rail crossing on 500 South remains at grade; however, a grade separated railroad by-pass route is provided between the intersection at 700 West/500 South and approximately 800 West/200 South. Thus vehicles stopped by the train on 500 South may choose to circumvent the closed rail crossing.

4.2 Traffic Volumes

Year 2030 peak hour traffic volumes were developed as described in section 3.2.

4.3 Truck Traffic

Truck traffic will continue to be a feature of the traffic mix in the future, based on the industrial land uses in the area. The 2030 Build 5-Lanes Scenarios will widen the roadway cross-section, and this widening will benefit truck traffic by providing larger turning radii for trucks and by enabling regular traffic to pass slow moving vehicles. The 3-Lane 2030 Build Scenarios will not significantly benefit truck traffic.

4.4 Access Management/Transportation System Management

The following access management measures were included as part of all future 2030 Build Scenarios:

- Provide curb and gutter along 500 South to better regulate access
- Signalize 1500 South on Redwood Road
- Consolidate closely spaced driveways to the extent possible

The following improvements to shoulders, passing lanes, and/or turning lanes were included as part of the 2030 Build analysis:

- Provide a shoulder for the study corridor
- Provide separate left-turn lanes (on SR-68) for all study intersections
    - For specific turn lane recommendations see Appendix D

4.5 Build Scenario Results

The results presented in this section are based on an average of five SimTraffic simulations. SimTraffic is a stochastic modeling tool, so each individual simulation has a different, random set of drivers, which reflects the slightly different traffic conditions seen each day at one particular location. Each individual simulation run will vary slightly. Intersections with less than one second of delay difference and travel times with less than five seconds difference across the multiple runs for the same scenario should be considered equivalent. Differences outside these ranges generally occur in scenarios including extreme congestion, reflecting highly unstable traffic flow.

Scenario 2
The 3-Lane TSM scenario results are also presented in Tables 15-17. For comparison purposes, the 2005 existing conditions and 2030 No Build conditions are also presented in these tables. Table 15 displays levels of service and delay for study intersections.

Table 15 – Existing, No Build, and TSM p.m. Peak Hour LOS and Delay

Intersection[3]	*Existing Condition* LOS / Delay[2]	*2030 No Build*[1] LOS / Delay[2]	*2030 TSM*[1] LOS / Delay[2]
I-15 SB Ramps / 500 South	D / 37.0	C / 31.9	D / 38.2
700 West / 500 South	C / 18.5	**F** / >50.0	D / 49.5
800 West / 500 South	D / 29.1	**F** / >50.0	**E** / 76.8
1100 West / 500 South		**F** / >50.0	**F** / >80.0
Redwood Road / 500 South	B / 12.5	C / 26.2	C / 30.1
1500 South / Redwood Road	A / 4.1	A / 8.3	B / 16.1
2600 South / Redwood Road	B / 12.4	**F** / >80.0	**F** / >80.0

Notes:
1) These scenarios generally service less than 90% of the traffic demand. Levels of service are in reality worse than those reported by SimTraffic.
2) Delay = seconds per vehicle
3) The SR 68 intersections between 700 West and 2600 South are not signalized under existing and No Build conditions (with the exception of the future Redwood Road / 500 South intersection).
Source: Fehr & Peers 2005

As shown in Table 15, intersection delay is sometimes worse in the TSM scenario than the No Build scenario. Several intersections are signalized in the TSM scenario. Overall intersection delay sometimes increases with signalization; however, delay for the worst movement improves. For example, the worst movement at the 1500 South / Redwood Road intersection for the No Build scenario is LOS E; however, the worst movement for the TSM scenario is LOS C. See Appendix D for intersection delay by movement.

Overall, the TSM network is better able to serve the transportation demand than the No Build scenario. The No Build simulations show long lines of cars queued at the entrances to the network by the end of the peak hour. Because these vehicles are not served during the recorded time period, their associated delay is not accounted for in Table 15. For the No Build scenario, 15% of the traffic is unable to get through the street system during the peak hour, therefore does not experience delay at the intersections that the traffic does not reach. For example, the Redwood Road/500 South intersection has less delay in the No Build scenario than the TSM scenario. Roadway improvements in the TSM scenario mean that this network is able to serve 157 more vehicles during the peak hour. This improved overall network performance for the TSM scenario is reflected by the improvement in network-wide delay (as shown in Table 17). Table 16 displays travel times for these scenarios.

Table 16 – Existing, No Build, and TSM p.m. Peak Hour Travel Times

Direction	*Existing Condition*	*2030 No Build*	*2030 TSM*
Northbound/Eastbound	6:40 min	9:13 min	12:47*
Westbound/Southbound	4:54 min	8:14 min	8:58*

*The travel time increases in the TSM scenario because signals were added. The added signals improve service to side-streets, but causes more through delay.
Source: Fehr & Peers 2005

Table 17 – Existing, No Build, and TSM p.m. Peak Hour Network Wide Delay

Scenario	*Existing Condition*	*2030 No Build*	*2030 TSM*
Network Wide Delay (sec / veh)	68	320	247

Source: Fehr & Peers 2005

As shown in Table 17, the TSM improvements increase travel time, but improves overall network-wide delay. However, neither the No Build nor TSM scenarios provide LOS D or better for all study intersections. These alternatives do not meet project purpose and need.

Table 18 provides study intersection LOS information for Scenario 3.

Table 18 – 2030 Scenario 3 p.m. Peak Hour LOS and Delay

Intersection	*3-Lane TSM with UPRR Grade Separation*
	LOS / Delay[1]
I-15 SB Ramps / 500 South	D / 40.3
700 West / 500 South	B / 11.6
800 West / 500 South	A / 9.1
1100 West / 500 South	**F** / >80.0
Redwood Road / 500 South	C / 24.7
1500 South / Redwood Road	B / 11.1
2600 South / Redwood Road	**F** / >80.0

Notes:
1) Delay = seconds per vehicle
Source: Fehr & Peers 2005

Table 19 displays the travel times for scenario 3.

Table 19 – 2030 Scenario 3 p.m. Peak Hour Travel Times

Direction	*3-LaneTSM with UPRR Grade Separation*
Northbound/Eastbound	8:38 min
Westbound/Southbound	6:07 min

Source: Fehr & Peers 2005

Table 20 provides network-wide delay information for this scenario.

Table 20 – 2030 Scenario 3 p.m. Peak Hour Network Wide Delay

Scenario	*3-LaneTSM with UPRR Grade Separation*
Network Wide Delay (sec / veh)	134

Source: Fehr & Peers 2005

Table 21 presents results for scenarios 4-7. These scenarios provide five-lanes for the entire length of the study corridor. For a description of each scenario see section 4.1.

Table 21 – 2030 5-Lane Scenarios p.m. Peak Hour LOS and Delay				
Scenario	***4) 5-Lane at Grade***	***5) 5-Lane Grade Separated UPRR***	***6) 5-Lane with By-pass, UPPR Grade Separated***	***7) 5-Lane with By-pass, UPPR at Grade***
Intersection	**LOS / Delay[1]**	**LOS / Delay[1]**	**LOS / Delay[1]**	**LOS / Delay[1]**
I-15 SB Ramps / 500 South	D / 35.6	C / 34.2	C / 34.4	D / 37.2
700 West / 500 South	B / 16.7	B / 11.4	B / 16.0	B / 17.5
800 West / 500 South	C / 34.2	A / 6.4		D / 36.1
1100 West / 500 South	B / 13.8	B / 13.0	B / 13.5	B / 13.9
Redwood Road / 500 South	B / 17.5	B / 16.1	B / 17.1	B / 16.5
1500 South / Redwood Road	A / 8.6	A / 8.7	A / 8.5	A / 8.7
2600 South / Redwood Road	B / 13.3	B / 12.9	B / 13.0	B / 12.4

Notes:
1) Delay = seconds per vehicle
Source: Fehr & Peers 2005

As shown in Table 21, Scenario 5 operates slightly better than Scenario 4; however, both scenarios have passing levels of service, meeting project purpose and need. The by-pass scenarios, scenarios 6 and 7, do not improve levels of service by a letter grade and occasionally cause delay to increase. These slight increases in delay are due to changes in traffic patterns cause by the by-pass route.

Table 22 presents travel times for scenarios 4-7.

Table 22 – 2030 5-Lane Scenarios p.m. Peak Hour Travel Times				
Direction	***4) 5-Lane at Grade***	***5) 5-Lane Grade Separated UPRR***	***6) 5-Lane with By-pass, UPPR Grade Separated***	***7) 5-Lane with By-pass, UPPR at Grade***
Northbound/Eastbound	7:19 min	6:08	6:08	7:25
Westbound/Southbound	6:27 min	5:34	5:40	6:20

Source: Fehr & Peers 2005

Table 22 shows that adding the by-pass route provides no transportation operational benefit due to the time taken to detour compared to the average gate closure, and in fact has a slightly negative affect on traffic patterns in the area. Table 23 presents the network-wide delay for scenarios 4-7.

Table 23 – 2030 5-Lane p.m. Peak Hour Network Wide Delay				
Scenario	***4) 5-Lane at Grade***	***5) 5-Lane Grade Separated UPRR***	***6) 5-Lane with By-pass, UPPR Grade Separated***	***7) 5-Lane with By-pass, UPPR at Grade***
Network Wide Delay (sec / veh)	65	45	50	64

Source: Fehr & Peers 2005

4.6 2030 Build Summary

The following future scenarios provide p.m. peak hour intersection LOS D or better at all intersections, meeting project purpose and need:

- **4) 2030 Build 5-Lane without UPRR Grade Separation**
- **5) 2030 Build 5-Lane with UPRR Grade Separation**
- **6) 2030 Build 5-Lane with 700 West By-pass and with UPRR Railroad Grade Separation**
- **7) 2030 Build 5-Lane with Grade Separated 700 West By-pass and UPRR at Grade**

Each passing scenario has advantages and disadvantages. Scenario 4 provides continuity throughout the corridor with the 5-lane cross section; however, intersections may occasionally experience added delay if trains stop for extended periods on the at-grade crossing. This situation may be improved by providing extra railroad track at this location for improved rail function within the Holly Oil property.

Scenario 5 would ensure smooth traffic operation through the UPRR rail crossing area, but grade separation will create additional impacts. Grade separation is not required to meet passing levels of service under average week day peak hour conditions if a 5-lane cross-section is provided.

Scenarios 6 and 7 also provide passing levels of service; however, the by-pass route would create additional impacts and these alternatives provide no significant benefit, considering the purpose and need of this project, when compared with scenarios 4 and 5.